The Mysore Agricultural Journal

(The Organ of the Mysore Agricultural and Experimental Union)

Vol. XXV] 1946-47 [Nos. 1 & 2

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IN THIS ISSUE

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The Company was floated in the year 1933 with a Capital of Rs. 20 lakhs chiefly on the initiative of the Government of Mysore who have subscribed more than half the share capital.

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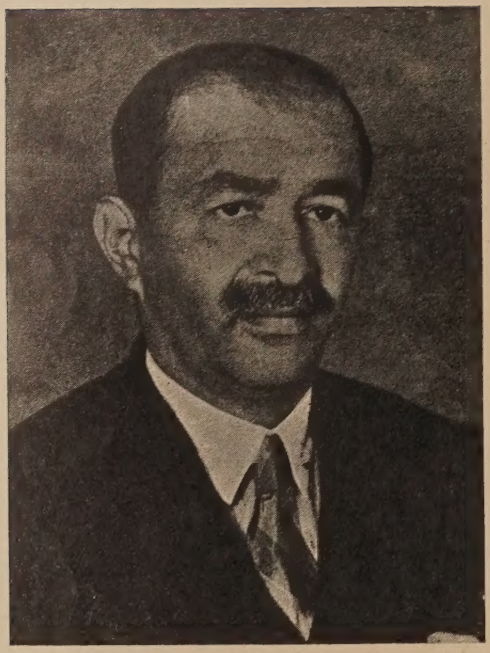

Dr. V. K. Badami, L.Ac., Ph.D.

The Mysore Agricultural Journal

(The Organ of the Mysore Agricultural and Experimental Union)

Vol. XXV] **1946—47** **[Nos. 1 and 2**

Dr. Venkata Rao K. Badami

L.Ag., Ph.D. (Cantab.)

1888–1946

To us, friends and colleagues of Dr. V. K. Badami, his sudden passing away on 27th August 1946 came as a great shock. It is needless to enumerate his academic distinctions and achievements. Suffice it to say that starting his career as a Junior Assistant he rose eventually to become the Deputy Director of this Agricultural Department, and later went to Orissa as Deputy Director and finally to Benares Hindu University as Principal, Agricultural College.

Dr. V. K. Badami did yeoman service in this Department. His work was very characteristic since much of it was of an exploratory and pioneering nature. Whatever work he undertook he executed it with consummate skill. His contributions toward the enrichment of certain economic crops are widely acknowledged. His name will always be associated with the evolution and introduction of H. 22 Ragi, H.G. 1 Groundnut, H.M. 320 and H.M. 544 Sugarcanes and S. 661 Paddy. His knowledge was versatile and his love for work exemplary. His kindness to his students and members of the staff was proverbial. His depth of understanding and breadth of vision always endeared him to whomsoever he came in contact with. His loyalty and devotion to the State were a revelation.

It is true that the old order changes, yielding place to new and that Divine justice fulfils itself in many ways which are inscrutable to mere mortals, yet Dr. V. K. Badami will be well remembered for a long time to come by his friends, admirers and colleagues.

L. S. D.

EDITORIAL

We are happy to announce that with this issue, we have completed 24 volumes of our journal and brought the numbers up to date. We are also happy to record that the fiscal year 1945–46 was a period of phenomenal progress in the activities of the Union. The membership reached a total of 2,500 and more applications for enrolment as members are being received from all parts of the State. Three District and 34 Taluk Committees have been formed and efforts are being made to organise such committees in all the taluks and districts of the State and to link up their activities with the extension service of the Department.

The part played by such non-official organisations in England and elsewhere, particularly in the second world war, has already become a great legend. England which produced only 40 per cent. of her food requirements in 1939, increased her output to 70 per cent. of her needs in the course of three years. No doubt, the extensive grass lands of England lent themselves for easy conversion into arable lands; but the great achievement would not have been possible but for the County War agricultural committees and the Women's Land Army—both voluntary organisations. Not only in England but everywhere, organisations like the C.C.C. (Civilian Conservation Corps) and 4-H. Clubs of America and the School Children's Army of USSR have rendered great service in the fields.

It is a happy sign for our country therefore that the Taluk Committees have been co-operating with the Department in the Grow More Food Campaign. We are sure that many more organisations will lend us their full co-operation in the great task of Reconstruction ahead of us. In this connection, particular mention must be made of the Mandya Taluk Committees under the inspiring leadership of Mr. S. C. Malliah, M.R.A., which has done yeoman service in popularising our Kar Ragi Drive in Mandya District. Government have granted Rs. 4,000 to be awarded as prizes to some of the Kar Ragi growers as a gesture of their appreciation of the good work of the ryots in growing more food. It is earnestly hoped that the other committees will emulate the splendid example of Mandya.

Finally, it is with pleasure that we record the splendid co-operation that the Revenue Department under the able guidance of Mr. Thipperudriah as Deputy Commissioner, Mandya, accorded to us in this campaign. We wish to thank all the officers of the Revenue Department for all the pains they took to make the campaign a signal success; and we earnestly look forward for co-operation and hearty support of the ryots, Agricultural Unions, leaders of public opinion and officers alike in our next Kar Ragi Campaign.

K. H. S.

DISEASES OF COFFEE

By S. V. Venkatarayan

Mycologist, Department of Agriculture, Mysore

Leaf Disease or Rust *Hemileia vastatrix* B. & Br.

The coffee leaf disease was first observed in an estate in the Mandulsima District of Ceylon by Thwaites in the year 1868. He took samples of the affected leaves to England, where Berkeley and Broome gave the name *Hemileia vastatrix* to the fungus. As regards the origin of the disease, Watt[48]* quotes Massee to show that it probably originated from some other species of *Hemileia* present on wild plants in or near the estate. Massee[18] says "to start a coffee plantation in the neighbourhood of the *Vangueria* would in all probability mean disaster." The allied species of *Hemileia* on *Vangueria, viz., H. Woodii* does not attack coffee. Butler and Bisby[9] record *H. Woodii* on Gardenia, but Sydow (probably on the authority of Massee) refers it to *H. vastatrix.* Thomas[42] has found *Vangueria spinosa* and *Randia uliginosa* attacked by a species of *Hemileia* morphologically identical with *H. vastatrix.* Butler[8] considers the disease to have originated in Africa, and to have crossed the ocean to Ceylon with living plants or other contaminated material. According to Doidge[12] and Arthur[2] the coffee rust is doubtless a native of eastern and central Africa where it is known on wild and semi-wild species of Coffea, and on *C. arabica.* From here it has spread probably with imported living plants.

Economic importance.—The disease is noted for the destruction it causes to the coffee, and the consequent loss to the industry. In ten years after its appearance in Ceylon it reduced the average yield per acre from 4½ cwt. to 2 cwt. and caused a loss of from 12 to 15 million sterling or 16 to 20 crores of rupees approximately. The annual loss from the disease there was over one million sterling or 135 lakhs of rupees. The disease is estimated to have caused a loss of about 35 per cent. of the yield in the Philippines, and about 50 per cent. in New Caledonia. There are no definite figures for the loss in India. But in Mysore, spraying in areas where the leaf disease is prevalent has given increased yields of from 100–200 per cent. So it may be assumed that the loss of crop is approximately 50–67 per cent.

Geographical distribution.—After its appearance in Ceylon in 1868 it soon spread far and wide. The next year it was noticed in Mysore and South India. It has been noticed in most

* Numbers refer to Literature cited.

of the coffee growing regions of Asia and Africa, and in the islands of the Pacific Ocean. It is confined to the tropics roughly from about 15° E. longitude eastwards to 170° W. longitude or as far as the international date line. It has not been known in West Africa, in the Americas, in the Antilles, and in Hawaii and Queensland.

The disease.—Leaf disease occurs mainly on the leaves, but sometimes also on the tips of the branches and on fruits. It appears as orange-yellow spots on the under surface of the leaves. The upper surface of the leaf does not show any symptoms at first, but later on brown patches appear directly above the spots on the lower surface. No spores are formed on the upper surface. This is because both for infection as well as for spore production the fungus requires the air-holes or stomata which are present for the most part only on the lower surface. The centre of the spots on the under surface turns grey or brown later, the margin remaining yellow. In the last stages the leaves turn brown and dry up. But even before this happens several leaves drop down, so that the assimilatory activity is considerably reduced. The orange-yellow powder is a mass of uredospores or summer spores that are mainly responsible for the dissemination of the fungus. The spores germinate under suitable conditions of moisture, temperature and light, and put forth germ tubes, which enter the leaves through the stomata. Germination takes place in a few hours to a day, and in ten days a minute yellow spot appears on the lower surface of the leaf. In about 14–17 days from infection the uredospores are produced. The orange spots are prominent usually on the third pair of leaves from the tip, as the incubation period of 14 days is just enough to allow two new pairs of leaves to form. The spots continue to bear spores for many weeks. The teleutospores or resting spores of the fungus have been found in India and Ceylon. An æcidial stage occurs on *Coffea arabica** in Mysore, *Aecidium nobile* Syd., but it has probably no connection with this fungus. The teleutospores are formed in the same manner as the uredospores and in the same spots, and have a thick and smooth wall.

Leaf disease is active under conditions of rainy weather, or when there is enough mist or dew to permit the germination of the spores, usually during the south-west and north-east monsoons from April to December (Mayne[22, 23]). Continuous heavy rain and strong wind tend to delay the spread of infection as a large number of spores may be blown astray or washed out. The

* Since sending this paper to the press Mundkur, B. B., and M. J. Thirumalachar ("Revisions of and Additions to Indian Fungi I." *The Imp. Myc. Inst. Myco. Pap.* 16 : 12, 1946) have adduced evidence to show that the leaves of the type specimen of *A. nobile* Syd. are those of *Pavetta indica* L., and that this fungus should therefore be considered to be *A. pavettæ* Berk.

showery-sunny weather of the north-east monsoon with occasional mist and dew are ideal conditions for the development of the disease. The disease receives a check during the dry months January to March, and this is the time when most of the infected leaves have fallen off the trees.

Host-plants.—All varieties of *C. arabica* are attacked by *H. vastatrix*, seedlings and old plants. *C. robusta* also gets the infection. *C. liberica* is a little more resistant to the disease than *C. arabica*, and the hybrids of *C. arabica* and *C. liberica* are even more resistant. *C. arabica* grafted to *C. liberica* has been a success in Java against leaf disease, although grafting work in the opposite direction has not yielded good results. *C. congensis*, a species closely allied to *C. arabica*, is resistant to leaf disease. In Mysore, *C. arabica* has been the only species cultivated on a plantation scale. Due to ravages of leaf disease and the stem borer *C. robusta* has gradually been planted although it is susceptible, but not to the same extent. The first type of *C. arabica* to be grown in Mysore was the 'Chik'. This proved very susceptible to leaf disease, and so was replaced by the 'Coorg' or 'Nalknad' type which was resistant for a time. Towards the end of the 19th century a number of hybrids were produced artificially. Some natural hybridization of *C. arabica* with *C. liberica* also took place. The hybrids have usually great vegetative vigour, and resistance to leaf disease, but show evidence of sterility associated with them, *viz.*, abnormalities of the anthers and pistils, malformation of the beans, and poor bearing. The berries, although of the arabica type, are to a large extent, empty. With the introduction of *C. robusta*, *C. arabica* × *C. robusta* hybrids were also produced, but none of them shows any promise. Selections have been made at various times by different planters. The most outstanding success with selection is to be attributed to Kent[17] of Doddengudda estate, whose Kent's arabica strain, once called hybrid, has now been planted for over twenty years in South India. This is partially resistant to leaf disease but does not breed absolutely true.

The Mysore Government Coffee Experiment Station near Balehonnur is the only one of its kind in India devoting its attention solely to coffee research. Work on plant breeding, disease and pest control are being conducted here. The plant breeding work so far done has given valuable results: four mother plants with outstanding merits and their progeny in several generations are being subjected to intensive tests in breeding. The work discussed in this section has all been carried out at the Station.

Resistance and susceptibility.—*H. vastatrix*, like many other rust fungi, exists in several physiological forms. The existence of two strains of the fungus was first reported by Mayne[24, 25] in

1932. In the course of testing of a number of selections, one S. 5/30 (from seed of a plant in Woger estate, N. Mysore, related to Kent's) was found to be completely resistant to spore collections made from the Coorg variety. Kent's selection was susceptible to spores from Kent's and S. 5/30, and not to those from Coorg leaves. This proved the existence of two strains of leaf disease behaving differently on different varieties of Coffee. S. 5/30 showed itself to be somewhat susceptible to the rust in the field. By 1938–39[21] four strains had been identified. The Chik and the Coorg varieties are susceptible to all four strains (Mayne,[21] 1938–39; and Mayne[28]) while Kent's is resistant to strains 1 and 3 and susceptible to 2 and 4. The mother plant S. 26 (a Balehonnur selection) is resistant to strains 1 and 2 and susceptible to 3 and 4 whereas the mother plant S. 44 is resistant to strains 1, 2 and 3, and susceptible to strain 4. The behaviour of these mother plants and their families in respect of resistance to the disease is peculiar. S. 26 shows practically no disease due to strain 3 in the field although standing not far off from its offspring family 288, which shows a considerable amount of the disease. In laboratory tests S. 26 is susceptible to strain 3. The mother plant S. 44 is susceptible to strain 4 both in laboratory tests and in the field, while its offspring family 353 is almost free from infection by this strain in the field. The disease strains evidently do not travel very fast. The breaking down of resistance of Kent's to leaf disease may be attributed to the commoner and more widespread occurrence of the leaf disease strain 2 while its earlier resistance is due to the absence of this strain from the locality. A selection like S. 26 resistant to two of the commoner forms of leaf disease may prove of value to planters for some time as Kent's has done. Kent's is resistant to strain 3, S, 26 to strain 2, while both are resistant to strain 1 and susceptible to strain 4, which shows that in some areas where Kent's is a failure S. 26 might prove valuable.

Mayne[21] (1934–35) has found resistance to strain 1 is a Mendelian dominant. The inheritance of resistance to strain 2 is governed by two factors one of which is probably the same as that governing strain 1. No case of a plant resistant to strain 2, and susceptible to strain 1 has so far been discovered (Mayne,[21] 1934–35). Resistance to strains 3 and 4 is determined by a single factor (Mayne,[21] 1939–40).

Control measures.—Spraying with Bordeaux or Burgundy mixture gives adequate protection against the disease. In Mysore Bordeaux mixture has given better results than Burgundy mixture (Mayne[27] and Mayne *et al.*[29]). The spraying work must be thorough, and the mixture evenly distributed on the lower surface of the leaves. The most favourable time for spraying is about a month after the blossom showers, or after the initiation of

rapid vegetative growth. Portions of the estate that usually get the disease early like sheltered areas should be sprayed first and the rest of the estate next, but before the advent of the south-west monsoon. A post-monsoon spray as early as possible after the south-west monsoon in combination with the pre-monsoon spray has given better results than either a pre-monsoon or a post-monsoon spray alone.

The first experiments on spraying were conducted with 2 per cent. Bordeaux mixture (8–8-40). It was soon replaced by one per cent. mixture (4–4–40), and then by ½ per cent. mixture (2–2–40), which is now in general use. Some planters even use the ¼ per cent. mixture (1–1–40) while others use an intermediate strength between the last two. An adhesive or spreader like resin-soda, linseed oil, or lime-caseinate was used in the earlier days, but recently it has been omitted from an economic point of view. Since the adhesive not only prevents the mixture from getting washed off during the rains, but serves to give a uniform covering of the mixture over the leaves, it seems advisable to use it.

Black Rot or Koleroga of Coffee

Corticium koleroga (Cke.) v. Höhn. *Pellicularia koleroga* (Cke.) was described by Cooke in 1876 from specimens collected from Mysore. The same or a similar disease has been reported from Venezuela, Jamaica, New Caledonia, the Belgian Congo, Porto Rico, Guatemala, Colombia, Trinidad, Surinam, Cuba, Brazil, Malaya, Queensland and the Lesser Antilles. An allied fungus *Corticium stevensii* causing a thread blight of apples, pears, quinces, grapefruit, orange, etc., is regarded by Wolf and Bach[49] as synonymous with *C. koleroga*. Butler[8] considers it probable that several different fungi attack coffee in a somewhat similar manner, and that it is doubtful if any country other than India suffers from this disease, excepting New Caledonia and Porto Rico. Narasimhan[36] thinks with Bally[4] that the spinne-webziekte of Java is different from *C. koleroga* while the zilverdraadziekte of Surinam, and the candelillo of Venezuela may be the same as *C. koleroga*. Coleman, Venkata Rao and Narasimhan[10] state that what looks like koleroga occurs in Java; Bally[4] says that koleroga is so far not known in Netherlands Indies, but that it is possible that a similar disease on tea may be closely related to or identical with it.

In Mysore the disease occurs in the region of the western ghats where heavy rain and mist are frequent, *i.e.*, in the higher elevations. It occurs to some extent in the lower elevations where *Hemileia* is predominant. It has been reported from Coorg, the Nilgiris, and the Shevaroys.

The disease starts soon after the south-west monsoon rains begin. The characteristic feature of the disease is a blackening

of the affected leaves, twigs and berries, whence the name black rot. The under surface of the affected leaves is covered by a thin, hyaline spreading web of fungoid tissue extending down by way of the petioles to the twigs and berries. The web constricts itself to a thick strand at the petioles by means of which the blackened leaves hang down even after detachment from the twig. This is an unmistakeable feature of the disease. The web or pellicle is discernible only when the leaves are comparatively dry. When moist, the web can be seen only with difficulty. Gradually the leaves and berries become brownish and finally black. A number of leaves and berries are shed, though some may be still hanging from the twigs. This is the pellicle stage (Narasimhan[36]), when the fungus is entirely superficial. It consists of interwoven threads, much branched, running in all directions, and one to three hyphæ thick. The fungus forms basidiospores during short periods of 10–15 days during heavy rains, probably in more than one such period. The basidiospore-bearing mycelium (Venkataraya[44]) is thicker and more whitish than the non-spore bearing mycelium, and is slightly granular after the manner of powdery mildews. It does not easily get wet, whereas the young mycelium does and becomes transparent. The basidiospores germinate easily, and serve to spread the fungus during the rains.

At a later stage the fungus forms sclerotia or hyphal clumps by repeated branchings of short cells. These are hyaline at first and become brownish later. They help to carry the fungus over the dry season. During the formation of the sclerotial stage the fungus penetrates the leaves through the stomata into the spongy and the palisade parenchyma (Narasimhan[36]). The affected leaves take on a brown colour at this stage, and later become black, perhaps due to secretion of oxidase as observed by Narasimhan[36] in pure cultures.

The fungus has a wide range of host plants. Besides coffee it has also been noticed to attack Strobilanthes, Dahlias, Crotons, *Jasminum* sp., *Randia dumetorum*, *Tabernæmontana coronaria*, *Gardenia gummifera*, *Wendlandia notoniana*, *Plectronia* (*Canthium*) *parviflora*, *Pavetta* sp., *Lawsonia alba*, *Dendrocalamus* sp., and two ferns *Pleopeltis linearis*, and *Niphobolus fissus*. It has definitely been noticed to pass from Jasminum to coffee[10] and from Plectronia (Canthium), Pleopeltis, and Niphobolus to coffee, and from coffee to Plectronia (Canthium) and the two ferns.[44]

As regards control of the disease, it is necessary in the first instance to remove, as far as possible, the dead leaves and twigs which harbour the resting stage of the fungus. This operation should be done before the break of the monsoon. The old leaves on the ground may be buried by a light digging. The other host plants of the fungus in the vicinity of the estate should be destroyed.

The best method of prevention of the disease is to spray the plants with one per cent. Bordeaux mixture (4–4–40), and an adhesive like resin-soda or lime caseinate. The spraying should be done towards the end of May or early in June before the south-west monsoon breaks out. The spray should reach the under surface of the leaves. Since the leaves are constantly expanding, and since new leaves are being formed during the monsoon months a second spray after the south-west monsoon in the month of September is necessary. If it is not possible to spray the whole estate, at least those portions which get the disease earliest should be sprayed thoroughly.

Spraying has been estimated to give an increased yield of about 65 per cent. It costs from Rs. 22–38 to spray an acre twice according to pre-war calculations. The increase in yield may be roughly estimated at 2–3 cwt. of coffee per acre, whereas the cost of the spraying will be only the cost of half a cwt. of coffee.

Brown Eye Spot (*Cercospora coffeicola*)

This is a common leaf-spot in Mysore, and sometimes becomes serious in the nursery, as in Uganda. It has been observed in all the coffee growing lands. In Central and South America, and in the Dutch East Indies, the fungus causes a spot on the berries, and sometimes destroys the beans. On the leaves, the spots may be nearly circular, up to about half-an-inch in diameter, and brown or brownish-red in colour. It is distinctly seen on the upper surface, and the spores of the fungus are found on both the surfaces of the leaf. When the disease is severe as in nurseries, spraying with Bordeaux mixture is necessary and it controls the disease.

Leaf-Spot [*Mycosphærella coffeicola* Cke., Syn (?) *Mycosphærella coffeae* Noack

There are several fungi causing leaf-spots on coffee mentioned in literature as occurring in various parts of the world. The above fungus occurring in Brazil, Venezuela and Surinam has been noted by Butler[8] in the Wynaad causing only trifling damage. It has not been observed in Mysore, and admittedly it is rare in the East, like the other American leaf disease caused by *Omphalia flavida* (*Stilbum flavidum, Stilbella flavida*). This latter is a serious disease surpassing in importance even *Hemileia*, and as destructive in America as *Hemileia* is here.

Cobweb Disease (*Corticium* sp.)

This disease has sometimes been passed over for koleroga or black rot caused by *Corticium koleroga*. But it differs from the latter in the nature of its spread on the leaf, in which it resembles the thread blights. According to Bally[5] it causes the

spinnewebziekte on coffee in Java. Pruning controls the disease to a great extent, but the prunings should all be collected and burnt, as the fungus can survive on them for some months. The fungus on the stems can be controlled by spraying with Bordeaux mixture as for black rot.

Sooty Mould (*Capnodium brasiliense* Puttem.)

The sooty mould is not a disease in itself, but only an accompaniment of the honey-dew found on the leaves and twigs infested with certain bugs and aphids. Its appearance makes the plants unsightly, and reduces the assimilatory activity of the leaves to some extent. The treatment consists in fighting the insects. Spraying with fish-oil resin soap or hongey oil resin soap regularly, controls the bugs. The bugs are harboured in some kinds of shade trees, and discontinuance of such shade lessens the infestation.

Pink Disease (*Corticium salmonicolor* B. and Br. Syn. *C. javanicum* Zimm.)

This is a serious disease of coffee in the Malay Peninsula, Burma, Ceylon, Java, Africa and Surinam. It attacks also Hevea rubber, tea, cinchona, Coca and cocoa and several other wild and cultivated plants. In South India according to Butler[8] it has been found on Hevea, tea, orange, mango, jack (*Artocarpus integrifolia*), camphor, Crotalaria and *Cassia mimusoides*. On coffee the fungus affects the twigs and fruits. The branches wither, and the fruits turn black. The fungus occurs in several forms. The most common kind is the Corticium stage, which occurs in the form of whitish or pink-coloured crusts on the twigs. The fungus develops under moist conditions in the same manner as black rot or koleroga. Pruning and spraying with Bordeaux mixture controls the disease.

Coffee Die-back or Anthracnose

Brown blight, Nilgiri twig disease; Black berry or Coffee berry disease. *Colletotrichum coffeanum* Noack. (*Glomerella cingulata* S. and v.S.)

Coffee die-back is caused by a fungus which has been known to cause various other symptoms on coffee. In the earlier years, Mayne[20] was disposed to think that environmental conditions played a great part in the causation of this disease, chief among which are soil, aspect, shade, and liability to leaf disease. He thought that previous over-bearing, and a present heavy blossom or crop tended to favour the disease. Defoliation either due to leaf disease or produced by heavy cropping, poor soil and light shade, he considered an essential preliminary. Later Mayne[21]

(1933–34) concluded as a result of several observations "that the onset of die-back was not necessarily preceded by defoliation, as shoots were frequently found in which shoot decay had commenced when a number of pairs of healthy leaves up to the apical bud were present". A severe outbreak of the disease in 1933 was explained by Mayne, Narasimhan, and Srinivasan[30] as being due to favourable climatic conditions for the development of the fungus.

According to Butler[8] the disease is fairly common in South India in Coorg, the Wynaad and the Nilgiris, and elsewhere is known in Brazil, Costa Rica, Porto Rico, East Africa and probably also in Java, Madagascar and Reunion.

The fungus causes spots on the leaves and the berries. On the twigs it causes a wilting of the young leaves, and death of a large number of shoots. Spots are formed on the internodes of twigs, and gradually the shoots die backwards and forwards, resulting in blackened bare twigs. The condition is similar to that described for the die-back of coffee in Uganda by Small.[39] A similar trouble, although assigned to a different but closely allied fungus, Gloeosporium, occurred in the Nilgiri and Nelliampati hills in 1904 (Butler[8]) and was called the Nilgiri twig disease. It spread in high elevation coffee estates, and was serious for some time, being considered to be worse than even leaf disease.

McDonald[34] considers Elgon die-back of coffee in Kenya to be non-parasitic. He says that various strains of Colletotrichum are responsible for a number of coffee diseases in Kenya, like brown blight and scab of the berries, anthracnose of the branches and brown blight of the leaves. The black berry or coffee berry disease in Kenya (McDonald[33]) attacks the berries, in the green stage, and completely destroys the beans. It involves, besides the berries, the berry stalks, and a small area of the twigs immediately adjacent to the base of the latter.

Hendrickk[16] in the Belgian Congo attributes the damage to coffee berries hitherto supposed to be caused by Antestia bugs to *Colletotrichum coffeanum* (see under black bean). He found humidity to be the most important factor affecting the development of the fungus, renewed outbreaks of which are invariably associated with showers of rain.

The remedy against the disease is spraying with Bordeaux mixture. Spraying done as a precaution against leaf disease or black rot acts as a preventive also against die-back. Even in a year of bad attack like 1933, as compared with a previous year (Mayne, *et al.*[30]) the amount of die-back on a sprayed block was about a third of that on the unsprayed block. The spraying had a beneficial effect although the severity of the disease was roughly three times as great as in the previous year. Spraying, while it

cannot ward off the disease, will prevent the further spread. In bad years, the application of two sprays before the monsoon to parts of estates especially liable to disease is suggested, the extra time between the blossom showers and the south-west monsoon being utilised for this purpose. If the question of cost is a consideration, it might perhaps be profitable to spray a second time before the monsoon, and omit the spray after the monsoon.

Black Bean

A group of diseases characterised by discolourations on the surface of the bean has received attention from several investigators in different parts of the world. According to Ukers[43] the term 'black bean' is used in the U.S.A. to designate dead coffee beans which have dropped from the trees before harvest.

Thomas[42] mentions finding spotted or stained or shrivelled beans inside healthy berries. He thinks the spotted bean is an early stage of the black bean. Munro[32] considers black bean to be bacterial. Light fruit of which he thinks black bean to be a type, he ascribes also to black rot, die-back and leaf disease. Mayne[26] says that black bean is not due to any parasitic agency, is present at least as early as the beginning of September, and does not increase during the subsequent period up to harvest. He mentions[21] (1937–38) three major types of defects, black bean, black jelloo and green bean. Black beans are heavier than black jelloo. Mayne finds that the black bean has an embryo, and quite normal in appearance. The green bean resembles black bean but its colour is green. He did not find that any of the artificial manures had any effect on black bean.

McDonald[33] thinks that the Coffee berry or black berry disease of Kenya attacking the berries in the green stage, and completely destroying the beans, is due to *Colletotrichum coffeanum*. Beckley[7] in Kenya describes a "yellowing of Coffee", a sort of chlorotic condition of the leaves accompanied by the collapsed or collapsing condition of one or even two beans in the cherries. He thinks that this is due to a deficiency of available nitrogen, and in his manurial experiments the attacked plants recovered in two months, and the collapsing beans filled up and were healthy. The Kenya Committee on Coffee berry disease[1] conducted spraying, manurial and cultural experiments to determine their effect upon the incidence and control of coffee berry disease with negative results. Wallace[47] in Tanganyika describes a coffee bean disease distinct from the Kenya disease, which takes the form of a blackening, drying and shrinking of the coffee beans, the fruit itself being healthy and growing to normal size. He ascribes this to two yeasts *Nematospora coryli* and *N. Gossypii*, which are introduced into the bean by punctures of the bug

Antestia lineatticollis. Rayner[37] has observed black bean symptoms in Kenya and considers the disease not to be caused by yeasts but to be physiological. He found the embryo or germ present in affected beans and says that it is "often more or less brown and will not germinate." Doughty at Amani, according to Rayner, is of opinion that faulty fertilization may produce a bean with normal endosperm but no embryo, and that in other cases a collapsed mass of tissue results, but this is usually not discoloured. Later Rayner[38] found that like berry fall, black bean could be induced by complete ringing and defoliation, and hence is due to a nutritional upset. "Complete defoliation produced a high proportion of black beans. Partial defoliation (leaving only three pairs of terminal leaves) combined with complete ringing was very effective, but by itself or combined with half ringing it had little effect. Half-ringing seemed little better than not ringing at all. Complete or half ringing when there was no defoliation produced few or no black beans." Hendrickk[16] believes that much of the damage attributed to infestation by *Antestia* sp., in the Belgian Congo is in reality due to *Colletotrichum coffeanum*. Berries attacked early fail to develop, and are totally unmarketable, being converted into a blackish mass. The spots on the green berries are sunken, brownish yellow, darker in the centre than in the periphery, later turning dark brown, and those on the ripening fruits are uniformly black, depressed and sticky to the touch. Even in a late attack on the berries he found in five batches each of 100 ripening berries, 13·6 per cent. floating due to partial or total disorganization of the endosperm, and 86·4 per cent. normal. Of the latter 6·37 per cent. showed Antestia damage and no symptoms were seen on 80·65 per cent. or 69·7 per cent. of the total number of beans. Small[40] in Uganda has found "lights" or "floaters" to be due to one or a combination of several factors like Hemileia, die-back, Colletotrichum blight, Cercospora blotch, variegated bug or unfavourable weather conditions during ripening. Averna-Sacca[3] in Brazil says the condition known as 'Cafe chocho' in which the bushes bear quantities of roughened, blackened, sometimes decayed berries which tend to fall prematurely may be caused by a number of fungi which he found on the berries.

Venkatarayan[45] in Mysore finds black bean associated with the absence of the embryo. The pericarp, fruit-stalks and twigs are unaffected. The affected berries do not fall off, but remain on the plant and feel like wilted fruits. One or both beans may be affected, and where only one is affected it has no embryo, while the healthy one has an embryo. The endosperm is collapsed and the parchment intact. The beans become very light coming up in the pulping vat as floaters. He suggests faulty pollination or fertilization leading to the suppression of the embryo and the consequent deterioration of the endosperm.

Such a feature is common in hybrids. Zimmermann[51] says that hybrid beans have a different colour from that of their parents and a large number of them are barren. Hybrids rarely give satisfactory yields. Doughty[13] in Amani speaking of interspecific crosses of *C. arabica* and *C. robusta* says that where *C. arabica* has been used as the female parent a fair number of seeds have been collected. The bulk of the seed has been poorly filled, and the texture rather spongy. but germination is fairly good. In the majority of the reciprocal crosses a similar development of the seed was obtained, but germination was a complete failure.

The losses from black bean are variously estimated. A planter says it is about 30 per cent. Thomas[42] says that in a bad season it is 25 per cent. Munro[32] found in one case of a perfectly healthy-looking branch every berry out of a total of over 50 to be diseased. Wallace,[46] in an exceptional case in Tanganyika, found in one plantation as many as 295 cherries in 300 with one or more discoloured or shrivelled beans, the yield being only 28 tons whereas the estimate of crop was 300 tons. Mayne's estimates vary from 3 per cent. to 20 per cent., but it must be even more, as during development, particularly from the 5th to the 11th week, a large portion of the fall of crop that normally occurs shows blackening of the bean tissue before the decay of the pulp.

Root Diseases

Brown Root Disease or Stump Rot, *Fomes noxius* Corn.

(*Fomes lamaensis* Murr., *Hymenochæte noxia* Berk.)

This is the commonest root disease of coffee occurring in Mysore, Coorg, Shevaroys and Nilgiris. It attacks *C. arabica*, and rarely *robusta*. Besides coffee it is known to attack a number of economic plants and jungle trees in different parts of the world. The disease is widely distributed in the tropics, and has been noticed in Ceylon, the Malay States, Java, Sumatra, New Guinea, Samoa and east and west Africa. It causes a serious collar and tap-root decay of the affected plants, and is generally known to spread from the stump of some cut-down jungle or shade tree, and hence the popular name stump rot for the disease. According to Butler[8] it has been observed in Mysore to spread to various species of *Ficus* and to *Grevillea robusta*. He gives a list of plants which are thought to be capable of spreading the disease or of themselves getting attacked. As many of these are shade trees in coffee estates, the spread of the disease to coffee is very easy.

Usually one or a few bushes are attacked here and there in the estate and in a severe case up to 150 bushes, while Butler[8] mentions an extreme case in which 40 acres was wiped out in 18 years. The leaves wither, and the bush dies rather suddenly. On digging it up, the tap root and the large lateral roots are found encrusted

with sand, earth, small stones, and brownish fungus hyphæ, the whole forming a gritty mass looking like charcoal. On removing the outer bark, the wood shows brown or black areas defined by black lines. No fructifications of the fungus have been observed in India, but the symptoms are very nearly allied to those of Hymenochæte disease of rubber, which in Malaya has been identified by Corner[11] as being due to *Fomes noxius* Corn. (*Fomes lamaœnsis* Murr.).

The spread of the fungus is by contact with infected roots. The fungus is incapable of spreading through the soil, unlike *Rosellinia arcuata*, the cause of another root disease, and hence the spread is very slow. Infected plants should be uprooted with as much of their roots as possible, removed to a safe place and burnt. If stumps of other plants are found, they should also be removed and burnt. If this operation is done thoroughly trenching is unnecessary. Liming the soil recommended by some does not seem to be beneficial, as lime is incapable of destroying the fungus. Replanting may be done almost immediately.

Mayne[20] says that the disease is generally a true stump rot, but that it is spore-borne in the Shevaroys. He does not describe the sporophores or spores. If the infection is spore-borne, it is necessary to protect the collars of trees with a fungicide like Carbolineum or Bordeaux paste, and also to protect wounds caused in the course of stumping, with tar or white lead.

Mayne[21] (1931-32 and 1932-33) conducted inoculation experiments with pure cultures of the fungus growing on blocks of coffee wood, burying these in contact with roots of young coffee trees in tubs. The conditions were a little abnormal on account of complete defoliation of the plants by leaf disease. Fourteen months later the plants were dug out, and out of the four plants inoculated, two which had the wood blocks in direct contact with the tap root, showed typical signs of infection while two which had the blocks near a lateral were free; the two control plants were also free.

Another serious root disease is that caused by *Rosellinia arcuata*. It occurs in Mysore on coffee, grevillea, and a number of jungle tree stumps in the heavy rain tracts. The same or a similar disease has been noted in Ceylon and Java. The fungus forms a greyish-black woolly mycelium on the surface of infected roots. Between the bark and the wood, white stars of mycelium may be seen. Fruit bodies are found in the form of black pellet-like fructifications on the stumps. Mayne[19] cites a case of *Rosellinia* associated with a busari stump (*Ficus*). He conducted a transmission experiment with infected pieces of tea, coffee and *Ficus* root placed in direct contact with roots of coffee plants in pots, and merely buried in the soil. In the next year[20] he

reported one success out of twelve infections from an infected tea root to the coffee. The large number of failures is due to the poor development of the fungus on the infective material used.

The methods of control are on the same lines as for brown root disease. Butler[8] recommends trenching in the early stages. Replanting is advised after a lapse of about eighteen months from the treatment.

Mayne[20] also mentions as agents of root disease *Irpex* sp. on a dead *Grevillea* in an area where a number of coffee trees had died. He[21] (1931–32) also mentions doubtfully (*Poria hypolateritia*), *Ganoderma pseudoferreum* (Wakef.) V. O. et St., the fungus causing the red root disease of tea; and another type of root disease caused by *Fomes applanatus*, a fungus causing root disease of tea in Ceylon.

EELWORMS OR NEMATODES. *Anguillulina similis*; *A. pratensis*; *syn. Tylenchus coffeæ*: *and A. multicincta*

In parts of Coorg and Mysore a very high rate of mortality in supply plants from one to five years' old has been found by Mayne and Subrahmanyam[31] to be due to two parasitic nematodes. Zimmermann[50] has described *Tylenchus coffeæ* parasitic on coffee on coffee roots, and Bally and Reydon[6] have treated this subject exhaustively.

The earliest symptoms of the trouble are a yellowing of the leaves, a loss of the young primaries and a stunting of the shoots. The plants gradually wilt and die. On digging up the plants, the lateral roots are found to have died, while a few adventitious roots may be seen in the top two inches of soil round about the tap root. The roots having completely died, the plants topple down at the slightest touch. The other eelworm causing root knot or root galls, *Heterodera marioni*, observed by Zimmermann in Java on coffee has not been found in India, though it has been noticed on the roots of dadap, *Erythrina indica* (Mayne,[21] 1935–36).

The nematodes penetrate the outer tissues of the roots, where they burrow and suck food from the cells. The injuries caused by these worms lead the way for infection by other organisms like fungi, bacteria and protozoa, and the destruction to the roots is complete. The nematodes are exceedingly small, being only about 0·5 mm. in size, the females being bigger than the males.

Inoculation experiments by Mayne and Subrahmanyam[21] (1936–37) have proved the ability of *A. pratensis* to attack healthy rootlets of coffee. Artificial inoculations with *A. multicincta* from dadap roots have been successful on coffee roots[21] (1937–38), though these worms have not been noted on coffee.

It is interesting to note that *A. similis* can attack some species of bamboo in addition to coffee and some green manure plants (*vide* Goodey[15]). Mayne[21] (1933–34) reports that some areas where supplies die are in the vicinity of bamboo jungle. But in Java the bamboo strain has been shown to be different from the strain on coffee. According to Bally and Reydon[6] inoculations with *A.* (*Tylenchus*) *similis* from *Coffea robusta,* while being successful on robusta coffee and *Vigna Hosei,* were unsuccessful with the bamboo, but the same strain from *Vigna Hosei* could infect arabica and robusta coffee and *Vigna Hosei* itself. *Tylenchus coffeæ* (*A. pratensis*) from robusta coffee successfully infected arabica coffee, and the two species of eelworms from bamboo failed to infect arabica and robusta coffee.

Control of nematode diseases has always been a difficult problem, and with a perennial crop like coffee it is greater still. Hot water sterilization of the supply plants, and chemical disinfection of the soil have both been ineffective. Manurial treatment of the soil has not yielded any results. On the contrary a depression has been noticed in the plots manured with potash (Mayne,[21] 1934–35).

No species of coffee seems to be free from infection by eelworms. Zimmermann suggested *C. liberica* as being less susceptible, either pure or as stock for grafts, but the results were unsuccessful. McDonald[35] in East Africa thought *C. excelsa* to be really immune to eelworm attack, but there is no mention of this elsewhere. He says that in the Belgian Congo attempts to graft *C. arabica* on the immune wild coffee, *C. myrthifolia,* were made, but that nothing further is known about this.

Phanerogamic Parasites

Balanophora.—This is a flowering parasite growing on the roots of coffee. It has no leaves of its own and hence is completely dependent for its existence on the coffee. It occurs here and there in Mysore. Its body consists of tuberous outgrowths from the lateral roots of coffee, consisting partly of the parasite and partly of the host. The males and females are separate individuals. The plant grows during the rains of the south-west monsoon, and puts out its flower heads about October-November. *B. indica* occurs in the Deccan peninsula, Nilgiri mountains and Ceylon. In Khandala it has been noticed also on the roots of *Carissa carandas. B. Thwaitesii,* another species, occurs in Ceylon. According to von Faber,[14] Van Breda de Haan mentions a Balanophoraceous parasite in Sumatra, which could not be identified for want of flowers, but probably belongs to the genus *Helosis.*

The growth of the parasite affects the vitality of the coffee plant, and decreases its yield. The only method of control is

to completely root it out as soon as the flowering spikes appear, and not allow them to mature the seed. A well-developed flower and its tubers may weigh as much as four pounds, and as many as five to ten clusters may occur on each coffee plant. Srinivasan[41] gives some statistics obtained from a planter, according to which 2¼ tons of tubers of the parasite have been dug out from a five-acre plot, and 2 tons from a nine-acre plot. This was a very badly affected estate where for over twelve years the parasite had thrived on a forty-acre block. The cost of eradication has been estimated at about five rupees per acre.

Loranthus

The species of Loranthus are occasionally seen on coffee. Unlike Balanophora, they are half-parasites possessing green leaves and drawing only water and nutrient salts from the branches on which they occur. They have no independent root system. According to von Faber[14] Ernst has noted *Loranthus orinocensis* Spr., *L. avicularis* Mart., and *L. parviflorus* Sw., on Coffee in Venezuela, and Delden Laerne has mentioned *L. brasiliensis* on coffee in Brazil. von Faber mentions *L. pentandrus* as being parasitic on *Coffea arabica* and other plants in the Greater Sunda Islands. Among other Loranthaceæ he mentions *Struthanthus marginatus* in Brazil and Paraguay, and *Phoradendron crassifolium* in Brazil.

All forms of Loranthus possess viscid fruits which form a source of food for birds. The seeds are surrounded by the viscid substance and are dispersed by the birds wiping their beaks against branches of trees in order to get rid of the adhesive pulp. Even if the birds swallow the seeds, the seeds come out uninjured in the excreta. The viscid substance causes the seeds to stick to the branch on which the excreta may be dropped, and the seeds get firmly pasted there by drying. On germination, the primary root penetrates the cortex of the host as far as the wood and spreads out to attach itself.

As control, the parasite should be removed with the root suckers or haustoria and destroyed. In bad cases a severe pruning may be necessary.

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For earlier literature see Watt (48) and Butler (8)

Abbreviations :—

M.C.E.S. The Mysore Coffee Experiment Station.
M.A.E.U. The Journal of the Mysore Agricultural and Experimental Union.
P.C. The Planters' Chronicle.
R. A. M. The Review of Applied Mycology.

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SOME WILD FODDER PLANTS OF MYSORE MALNAD AREAS

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Malnad forests consist of a variety of plants many of which will be in full leaf throughout the year. In all the seasons some or other of the plants put forth new growth so that tender leaves and twigs are obtainable throughout the year. Especially in the dry months from December to April, when the supply of green grass is scarce, the tender fellings from trees and shrubs are used as cattle fodder. The paper, "Wild Fodder Plants of Mysore," by K. Gopala Iyengar, M.Sc., and S. G. Narasimhachar, M.Sc., published recently (*The Mysore Agricultural Journal*, Vol. XXIII, No. 4, 1945), though exhaustive, is not complete. The author has observed a number of plants that are eaten by cattle—some greedily and some under compulsion during times of scarcity. A list of these which supplements the paper cited above, is given below.

Observations have been done mainly on cattle in and around the Government Coffee Experiment Station, Balehonnur. My grateful thanks are due to Mr. K. H. Srinivasan, M.A., B.Sc. (Edin.), for his kind encouragement.

No.	Name	Family	Kannada Name	Remarks
1	*Acacia torta*, Craib. ..	Leguminosæ		This is a common scandent shrub with small prickles. Tender shoots are eaten by cattle.
2	*Albizzia stipulata*, Boivin. ..	do	Hotte Bage	This is a tree used as shade for tea and coffee. The fellings consisting of tender leaves and shoots are a source of fodder.
3	*Angiopteris*, sp. ..	Fern		The plants grow in moist situations. The tender fronds are eaten by cattle in times of scarcity.
4	*Argyreia pilosa*, Wt. and Arn. ..	Convolvulaceæ	Samudraballi	This is a large hairy climber commonly met with. Cattle feed upon the leaves
5	*Atylosia lineata*, W. and A. ..	Leguminosæ	Kadu-Togari	The plant is an erect compact bush with yellow flowers having a striking resemblance to Togari. Cattle eat the tender twigs and leaves. The plants are not very common.
6	*Chasalia curviflora*, Thw. ..	Rubiaceæ		This is a small shrub, looking fragile, with fine blue and curved flowers. Cattle eat the entire plant with a relish.
7	*Cipadessa baccifera*, Miq. ..	Meliaceæ	Chittundi	This is a small much branched tree with white flowers. Cattle eat the leaves sparingly in times of scarcity.
8	*Coffea*, Sp. ..	Rubiaceæ	Coffee	Coffee plants are sometimes eaten by the cattle though generally they are not.
9	*Crotalaria usaramoensis* Baker	Leguminosæ		These are two introduced species which are sometimes used as temporary shade for coffee. Cattle can be forced to feed upon these though they do not prefer these.
10	*C. anagyroides* H. B. K.	do		
11	*C. striata* var. *acutifolia*, Trim.	do		These three species are erect shrubs. Cattle eat them sparingly.
12	*C. lanata*, Bedd.	do		
13	*G. Heyneana*, Grah.	do		
14	*C. fulva*, Roxb. ..	do		This forms a fine bush with yellow flowers. Cattle relish the plants.
15	*C. retusa*, Linn. ..	do		This shrub is eaten under force by cattle.
16	*C. bifaria*, Linn. ..	do		The plants grow as stragglers, and cattle browse them.
17	*C. dubia*, Grah. ..	do		This is a small erect plant with a head of flowers, Cattle eat the plants well.
18	*C. prostrata*, Roxb. ..	do		This is a prostrate herbaceous plant growing amidst grass. Cattle eat the plants readily along with grass.

19	*Cyclea Burmanni*, Miers. ..	Menispermaceæ	Padavali-Balli	A small climbing shrub with peltate leaves which is greedily eaten by cattle.
20	*Desmodium cephalotes* var. *congestum*, Prain	Leguminosæ		A hairy shrub growing up to 15 ft. in favourable situations. Cattle readily eat the leaves and tender shoots.
21	*D. triquetrum*, DC. ..	do		A small erect shrub with simple leaves. Cattle browse upon the plants.
22	*D. laxiflorum*, DC.	do		The two species are small shrubs. The cattle browse readily upon the plants.
23	*D. polycarpum*, DC.	do		
24	*Dumasia villosa*, DC. ..	do		A slender climber that is greedily eaten by cattle.
25	*Entada scandens*, Benth. ..	do	Halleykayiballi	This is a gigantic climber growing over tree tops and is always in full leaf. Cattle relish the leaves very much.
26	*Erythrina lithosperma*, BL. ..	do	Dadap	Dadap is an introduced species commonly used as shade for coffee. Particularly in coffee estates a good quantity of fellings can be obtained during dry months when green grass is in scarcity. Cattle like to eat the tender shoots and leaves.
27	*Flacourtia Ramontchi*, L'Herit..	Bixaceæ		A small tree with thorns. Tender shoots are eaten well by cattle.
28	*Grewia disperma*, Rottl.	Tiliaceæ	Kaori	These two are small trees that are commonly met with. The leaves and tender shoots form a source of fodder for the cattle.
29	*G. Lawsoniana*, J. R. Drumm.	do		
30	*G. umbellata*, Roxb. ..	do		The plants are scandent and shrubby. The leaves are eaten by cattle.
31	*Helicteres Isora*, Linn. ..	Sterculiaceæ	Yedamuri	This is a shrub or a small tree with characteristic bifarious leaves. Cattle eat the leaves especially during times of scarcity.
32	*Ipomœa hispida*, Roem and Sch.	Convolvulaceæ		These three species are slender twiners. Cattle feed upon these in a mixed fodder.
33	*I. Clarkei*, Hook.	do		
34	*I. obscura*, Ker-Gawl.	do		
35	*Jasminum malabaricum*, Wight	Oleaceæ	Kadu mallige	The three species of Jasmins are large climbing shrubs very common on the Station. Cattle eat them with a relish.
36	*J. Ritchici*, C. B. Clarke	do	do	
37	*J. pubescens*, Willd.	do	do	
38	*Jussieua suffruticosa*, Linn. ..	Onagraceæ	Kavakula	A small hairy shrub that is browsed by cattle.
39	*Lantana aculeata*, Linn. ..	Verbenaceæ	Lantana	The lantana is one of the unwanted troublesome plant species which grows luxuriantly. Cattle eat the leaves sparingly in times of scarcity.
40	*Mimosa pudica*, Linn. ..	Leguminosæ	Muttidare Muni	The sensitive plant is another unwanted troublesome plant species. It is browsed upon by cattle.
41	*Osbeckia truncata*, Don.	Melastomaceæ		These two herbaceous plants growing amidst grass are readily eaten by cattle.
42	*O. cupularis*, Don.	do		

No.	Name	Family	Knnnada Name	Remarks
43	*O. hispidissima*, Wt. ..	Melastomaceæ		This is a hispid shrub which is eaten well by cattle during times of scarcity.
44	*Pothos scandens*, Linn. ..	Araceæ	Adkebien-Balli	This is a climbing plant clothing trees and walls like ivy. The plants are greedily eaten by cattle and apparently relished by them.
45	*Pteris* sp. ..	Fern		This common fern which can be found growing in moist situations during the dry months and in other seasons is very common, is fed to cattle during the dry months and the cattle eat the fronds after getting used to them.
46	*Sida rhombifolia*, Linn.	Malvaceæ	Bennegaragu-	These herbaceous weeds growing either in waste places or amidst grass are readily browsed by cattle.
47	*S. glutinosa*, Cav.	do	gida	
48	*S. veronicæfolia*, Lam.	do		
49	*Solanum nigrum*, Linn. ..	Solanaceæ	Kari Kachi	This annual is greedily eaten by cattle.
50	*S. indicum*, Linn. ..	do	Kempu Gulla	This much branched, prickly undershrub is also greedily eaten.
51	*Strobilanthes Heyneanus*, Nees.	Acanthaceæ		This is a hairy shrub which is very well eaten by cattle.
52	*S. ixiocephalus*, Benth. ..	do		This is a small straggler which is also well eaten by cattle.
53	*S. barbatus*, Nees. ..	do		This is a large shrub. All the three species of Strobilanthes form a good source of fodder that are very much liked by the cattle. For days together the cattle have been fed with only these plants and they have readily eaten these without leaving even a small twig.
54	*Triumfetta pilosa*, Roth.	Tiliaceæ		These herbaceous weeds are greedily eaten by cattle.
55	*T. rhomboidea*, Jacq.	do		
56	*Urena lobata*, Linn. ..	Malvaceæ		A common herbaceous weed browsed by cattle.
57	*U.* sinuata, Linn. ..	do		This shrubby plant is very well eaten by cattle.
58	*Vitis discolor*, Dalz. ..	Vitaceæ		This slender ornamental climber is much eaten by cattle.
59	*Ziziphus horrida*, Roth. ..	Rhamnaceæ		This shrubby plant with thorns is quite common at the Station. Cattle browse upon the tender shoots and leaves especially during the dry months.

COMPOST FROM TOWN REFUSES

By Dr. S. V. Govindarajan, B.Sc. (Hons.), Ph.D. (Lond.), etc.
Bio-chemist

The Economics of the Composting Process

The process of composting has been described in an earlier issue of this Journal (Kannada Journal, November 1944). Stated briefly this process consists in mixing all types of organic refuses (street sweepings, dust-bin refuse, etc.) in alternate layers with natural "starters" like nightsoil, slaughter-house wastes, sewage or sludge, in the requisite proportions and allowing biological decomposition to progress and ultimately produce a product which is fit for application to land as manure. This process can either be carried out in trenches, an essential part of the "Bangalore Process", or where this is not practicable, in overground heaps, and accordingly the methods are referred to as the "Trench Method" or the "Overground Heap Method".

The Trench method possesses numerous advantages over the Heap method and among these may be stated:—

(1) Filling trenches with refuse and nightsoil in layers in a systematic manner is both easier and labour-saving than forming heaps.

(2) The loss of moisture particularly during the summer months, is reduced to a minimum, thus saving in water and labour.

(3) A better quality manure is recovered at the end of the decomposition process due to prevention of losses of manurial ingredients by rain leaching and by volatilisation.

(4) The quantity of manure finally recovered is greater due to the controlled decomposition processes.

(5) Trenches are space saving, while heaps take up more space.

(6) The possibility of smell and fly nuisances are at a minimum in trenches.

(7) Better check can be kept over the total quantities of manure produced and disposed off at the compost depot. The exact quantity available is estimated by the number of filled up trenches and their capacity. In overground heaps the loss of manure cannot easily be detected.

The cost of production of compost may be split up into two chief items: (*a*) "recurring" and (*b*) "non-recurring" expenditure. The first one includes the labour charges in processing the refuse material and the second one in the initial cost of layout of the trenches, roads, etc., connected with the compost depot. With regard to the labour required, it is found by experience in a number of centres in Mysore State and also elsewhere, that one labourer can handle 120–150 cubic feet of refuse together with 200–250 gallons of nightsoil per working day. These quantities represent about one ton each of rubbish and nightsoil. Taking the average wage of a labourer at As. 12 per day, this amount represents the cost of producing 2 tons of mixed compost material. Normally no turnings are necessary and any watering of the compost mass that may be needed can be carried out by the labour engaged on trench filling. As such the cost involved is that on labour needed for routine filling of the trenches. After decomposition the mass loses weight and volume and approximately 1½ tons of mature manure are recovered out of every 2 tons of mixed materials. The production costs "recurring" therefore works out at As. 8 per ton (50 cubic feet) of finished compost. Where the wages are higher or where additional expenditure is incurred in supervision of the depot, the cost of production will be somewhat higher.

The "non-recurring" expenditure will include the cost of excavation of trenches, and other items involved in the permanent layout of the compost depot. In practice it is found that trench costs alone are involved, since the layout of the roads or fencing the depot with live plants can be carried out without incurring extra expenditure. The cost of excavation ranges from Re. 1 to Rs. 1–8–0 per 100 cubic feet of earth. This trench volume will contain 2 tons of mature compost and as such the cost of trenching works out at about As. 8 to As. 12 per ton of manure produced in trenches. This is only an initial expenditure and as the trenches can last more or less indefinitely, once this cost is recovered by the sale of manure, it ceases to influence the cost of compost preparation.

According to the figures given under the above two items, the cost of production of manure in the first lot comes to Re. 1 to Rs. 1–4–0 per ton. Town refuse compost fetches a price ranging from Re. 1 to Rs. 5 per ton depending on the locality and the keenness of the local demand, as has been our experience during the past three years in different parts of the State. This price is sufficient to cover the initial trench excavation costs and the labour charges and even leave a margin of profit. In the production of subsequent quantities of manure from these trenches, only the labour costs count and all income over this item of expense, is profit. This profit has been found to range from

As. 8 to over Rs. 3 for every ton of compost produced and sold. As such composting of town refuses is found to be an undertaking profitable to the municipalities. As an example, a town with a population of say 10,000 will have a maximum production capacity of nearly 1,000 tons of compost per annum and the profits from compost sales will represent a substantial income to the Municipality, and prove an effective stimulus for undertaking this work. Also this will prove a convenient means of supplying to the agriculturists bulky organic manure of good quality, from numerous centres spread all over the State.

A Profitable Municipal Undertaking

The economics of production and sale of Town Refuse compost by municipalities is detailed here in a schematic manner. A town of 10.000 population is taken as example and the estimates made here are applicable in an approximately proportionate manner to other towns with larger populations. With smaller towns the actual quantities of refuse materials recovered fall somewhat short of the amounts anticipated on the above basis owing to the practical difficulties in effecting complete collections of the refuse materials.

Annual Out-turn of Compost

Population of town ..	10,000.
Daily collection of refuses ..	200 to 250 cubic feet.
Daily collection of nightsoil (upto a maximum of 400–450 gallons) ..	70 cu. ft.
Total daily collections of all types of refuse	4 tons.
Estimated annual production of mature compost	800 to 1,000 tons.

Production Costs

(1) *Non-recurring expenditure.*—This is largely the cost involved in layout of trenches in the depot.

Cost of excavating 100 cu. ft. of trench volume ranges from Re. 1 to Rs. 1–8–0 or As. 8 to As. 12 for trench volume required to produce one ton (50 cu. ft.) of manure.

A number of trenches adequate to deal with 8 to 10 months' production will usually suffice, since the manure maturing within this period will be sold off and the older trenches released for refilling. The cost of excavating trenches sufficient to hold 700 tons (about 9 months' production) at above rates will be within Rs. 450. This is only an initial expense which can be recovered out of the realisations from the sale of the first lot of manure produced in the trenches.

(2) *Recurring Expenditure*:—Labour charges.

Labour needed to deal with above stated quantities of refuse ..	2 men (sweepers)
Labour costs per annum (at Rs. 20 p.m. each)	Rs. 480
Implements (baskets, rakes, etc.) say	,, 25
TOTAL ..	,, 505
Total expenditure in first year (items 1 and 2)	Rs. 955

Realisations

The sale price of compost (average) ..	Rs. 1-8-0 per ton.
Annual estimated income to Municipality from the sale of compost ..	Rs. 1,200 to 1,500

Profit

The profits in the first year (in round figures) will range from Rs. 250 to Rs. 550. In subsequent years when the expenditure on item (1) above is recovered, the net profits will be larger. These may be estimated to vary between Rs. 800 to Rs. 1,000 per year.

The above profits are on the assumption that the compost sells at only Rs. 1-8-0 a ton. At the present day the demand for good manure is so keen, that compost which is invariably superior in quality to ordinary farmyard manure, fetches a much higher price. In consequence, the realisations and the net profits to the municipalities from compost sales are also much higher.

"GROW MORE FOOD" CAMPAIGN

Extract from the letter of a landholder to the Director of Agriculture

RAGI GROWS WHERE PADDY FAILS

"To do my humble bit in making grow more food campaign a real success, 10 acres of wet land were brought under irrigated ragi cultivation by digging 3 wells of 50′ by 50′ dimensions in Jodi Yelichagoppa village, Magadi Taluk, Bangalore District.

One ragi stool plucked at random is enclosed as a sample. You will be glad to learn that this crop is obtained in a place where paddy crop failed for lack of rains only 9 months ago."

* * * * * *

(Sd.) A. J. KHALEEL.

IMPORTED GRAIN: A WARNING

Do Not Use for Seed Purposes

With a view to relieve distress threatened by famine and avert disaster, large quantities of rice, wheat, maize and millets have been and are being imported into India. Before export, rice is processed by the removal of husk so that it is rendered useless as seed. That, however, is not the case with the other grains. As there is a likelihood of scarcity of cereal seed due to its utilization as food, it is probable that some of the imported cereals may be used as seed by the farmers.

Seed-borne parasites.

Several diseases of wheat, maize and millets due to fungi and bacteria are seed-borne and some of those parasites do not occur in India at present. It is clearly not possible to treat the thousands of tons of cereals that may enter the country within the next few months; in any case most of it will be consumed as food. But the farmers may feel tempted to use a small quantity for seed. Using such grain which may carry some seed-borne parasite is very hazardous and every means must be adopted to prevent it.

India is lucky that some of the parasites do not occur here. *Ophiobolus graminis* for example causes the dreaded disease of wheat known to the Australian, Canadian and New Zealand farmers as '*take all*'. The losses it causes are enormous and in some seasons are stated to be more than those caused by all the rest of the wheat diseases put together. Some of the fungi occur in India but that does not mean that they should not be kept out of the country. In fungi there are races which are not distinguishable on morphological grounds but which vary in the degree of parasitism they possess. For example, loose smut due to *Ustilago tritici* is common in several wheat-growing tracts of India and it is now known that there are two parasitic races of it. This is an internally seed-borne disease and other races of it, which do not occur in India and which may attack our wheat varieties that are immune or highly resistant to our races, may be imported into India with imported wheat.

Avoiding the use of imported grain as seed appears therefore to be the only feasible way of keeping out these diseases.

—(*Adapted from a note by Dr. B. B. Mundkur in "Indian Farming", Vol. 7, No. 4, pp. 198–199, April 1946.*)

UNION MEMBERS MEET THE RETIRING AND THE NEW DIRECTORS OF AGRICULTURE

The members of the Agricultural and Experimental Union had a small gathering on the 4th of July 1946 to meet the retiring Director of Agriculture, Mr. M. J. Narasimhan, B.A., and the new Director of Agriculture, Mr. K. H. Sreenivasan, M.A., B.Sc. (Edin.). Mr. S. Srinivas, President of the Bangalore Taluk Committee of the Mysore Agricultural and Experimental Union, addressed a few words to the chief guest and the incoming Director. His speech is reproduced here. Mr. G. S. Subbaratnam, one of our life-members, also spoke a few words of appreciation and felicitation and the gathering terminated with suitable replies from Mr. M. J. Narasimhan and Mr. K. H. Sreenivasan.

Speech of Mr. S. Srinivas

"MR. M. J. NARASIMHAN, Sir,

Permit me to say a few words on behalf of myself and the Agricultural and Experimental Union, to you, on this occasion, when you are laying down your office as the Director of Agriculture. The Department has earned a name on account of your solid work as a scientist, especially in connection with the Koleroga of Areca-nut in the Malnad. You took up the Directorship of the Department during the war years and you have guided it at a time when the supplies to the raiyats of seeds, manures and iron materials have gone on increasing many times their pre-war volume.

Our Union has considerably expanded in your regime. From barely 400 the membership went up to nearly 2,000, and by way of Regional Committees started as a new feature, we have already formed 3 District Committees and about 20 Taluk Committees, besides having about 40 Village Associations on our lists. The attendance at our annual meetings has been extraordinary for the last two years and the Government have seen their way to increase our subvention on your recommendation. You are leaving us as Director of Agriculture, but Sir, I hope you will certainly continue to be a member of our Union and help us with your suggestions and contributions.

We wish you all happiness in days to come.

To you, Mr. K. H. Sreenivasan, our hearty welcome on the assumption of your new office. You, Sir, succeed to a regime during which the raiyats more than ever turned to the Agricultural Department. Several post-war plans have been drawn up and

Group taken when the members of the Agricultural and Experimental Union met the retiring and the incoming Directors of Agriculture

Sitting 3rd from the left Mr. K. H. Sreenivasan, M.A., B.Sc.
„ 4th „ „ „ Mr. M. J. Narasimhan, B.A.

they have to be worked through. You have had your share, Sir, in chalking out the lines of development for our Union and building of a Union Home, the establishment of a Union Library, further organisation of its Regional Committees, increase in the number of its life-members and many an other development which you are aware of require your sympathetic support from your new office.

We wish you all success."

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